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Ionospheric propagation high latitude and equatorial studies are included in this research. Emphasis is on three magnetic storms in January, April, and May 1997 with data obtained from GPS satellites on rate of change of total electron content. One storm (April 10-11, 1997) penetrated to equatorial latitudes with phase fluctuations showing at the anomaly latitude of Santiago, Chile. The study of a large number of data sets for October 1996 was completed and accepted for journal publication.

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OFFICE OF NAVAL RESEARCH

Technical Report

for

January 1, 1998 - June 30, 1998

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SCIENTIFIC AIMS

As we have stated in earlier reports, the aim of the studies is to identify the necessary and sufficient conditions for the creation of ionospheric irregularities, primarily at equatorial latitudes. We are searching for means of identifying the parameters at high latitudes which produce effects at equatorial latitudes. The instability processes by which F layer irregularities develop are different for high latitude and for equatorial irregularities. At high latitudes electric field changes during a storm, which can be highly localized, produce high intensity irregularities. At equatorial latitudes instability mechanisms, primarily the Rayleigh Taylor instability, has been thought to be the primary reason for the growth of plume like irregularities near the magnetic equator. Using radio and optical observations, we would like to find the triggering mechanism for equatorial irregularity development. These could range from lower atmosphere conditions to substorm activity at high latitudes. The processes involve neutral winds in the ionosphere, horizontal and vertical gradients of electron density, velocity of F layer plasma, and shears in electron density.

A REVIEW OF EQUATORIAL IRREGULARITIES DURING A MONTH AT SOLAR MINIMUM

During the month of October 1996, Cornell University, Clemson University, and Boston University, all under ONR sponsorship, took an intensive series of measurements in South America. Boston University has brought them together with other data to produce a comprehensive review of a typical month of equatorial development. Boston University had two contributions i.e. optical observations from two sites (Arequipa, Peru and Tucuman, Argentina) and GPS phase scintillations taken all across South America. It is intended to show daily behavior rather than the worst case scenario. Using the GPS data from this and other months, the dynamics of the formation of the anomaly region are being studied in order to better forecast scintillation on communications and navigation systems. Additional data for validation of the concepts were taken during MISETA 97 when intensive observations were made in October and November 1997.

RECENT STUDY

At high latitudes the unique data of GPS phase scintillations taken simultaneously at many stations in the auroral oval were matched with the optical observations of the entire auroral oval of the Ultra Violet Imager of the POLAR satellite. The development of both phase scintillations from GPS and optical auroral development were correlated across the entire auroral oval. A paper has been reviewed, revised, and accepted for publication and will appear in the special issue on magnetic storms of the Journal of Atmospheric and Terrestrial Physics. The abstract appeared in our last report.

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With the database of many stations in South America available to us, it is possible to look at the annual variation of phase fluctuations at sites on the magnetic equator. This has been done with phase fluctuation for the entire year of 1996, a period of low solar flux. We found that the occurrence of the phase scintillation that we observe is extremely well correlated with that of amplitude scintillations. The patterns for Arequipa and Fortaleza in South America match those of published data on amplitude scintillation.

While it is admitted that amplitude and phase scintillation have at times somewhat different patterns, the correlation of this new data on phase scintillation with amplitude scintillation is important in allowing the forecasting of both phase and amplitude scintillation.

We now have a large database with observations at auroral and polar latitudes as well as equatorial latitudes. We shall continue to look for means of transmission of the effects of magnetic variations that appear at the high latitudes to the equatorial latitudes. Essentially we wish to determine what the characteristics of magnetic storms that have an effect on the equator along the same magnetic longitudes. We also have available magnetograms of many high latitude stations. The shielding which takes place at high latitudes prevents penetration of some storms to middle and equatorial latitudes. The timing of the shielding relative to the longitude of the equatorial station is a subject to be studied with the aim to identify the magnetic storms which produce serious problems on communication and navigation systems at both equatorial and high latitudes.

RESULTS/CONCLUSIONS

The recent data taken during October and November 1997 are still being analyzed as well as the data from the great magnetic storm of May 1998 (where Kp reached 9). For the 1997 period two magnetic storms occurred. A very quiet period with low fluctuations at high latitudes can be noted for October 22. Beginning on October 24, irregularities develop at high latitudes. The equatorial anomaly stations such as Santiago and La Plata show irregularities. Data for optical and radio studies are being reduced.

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